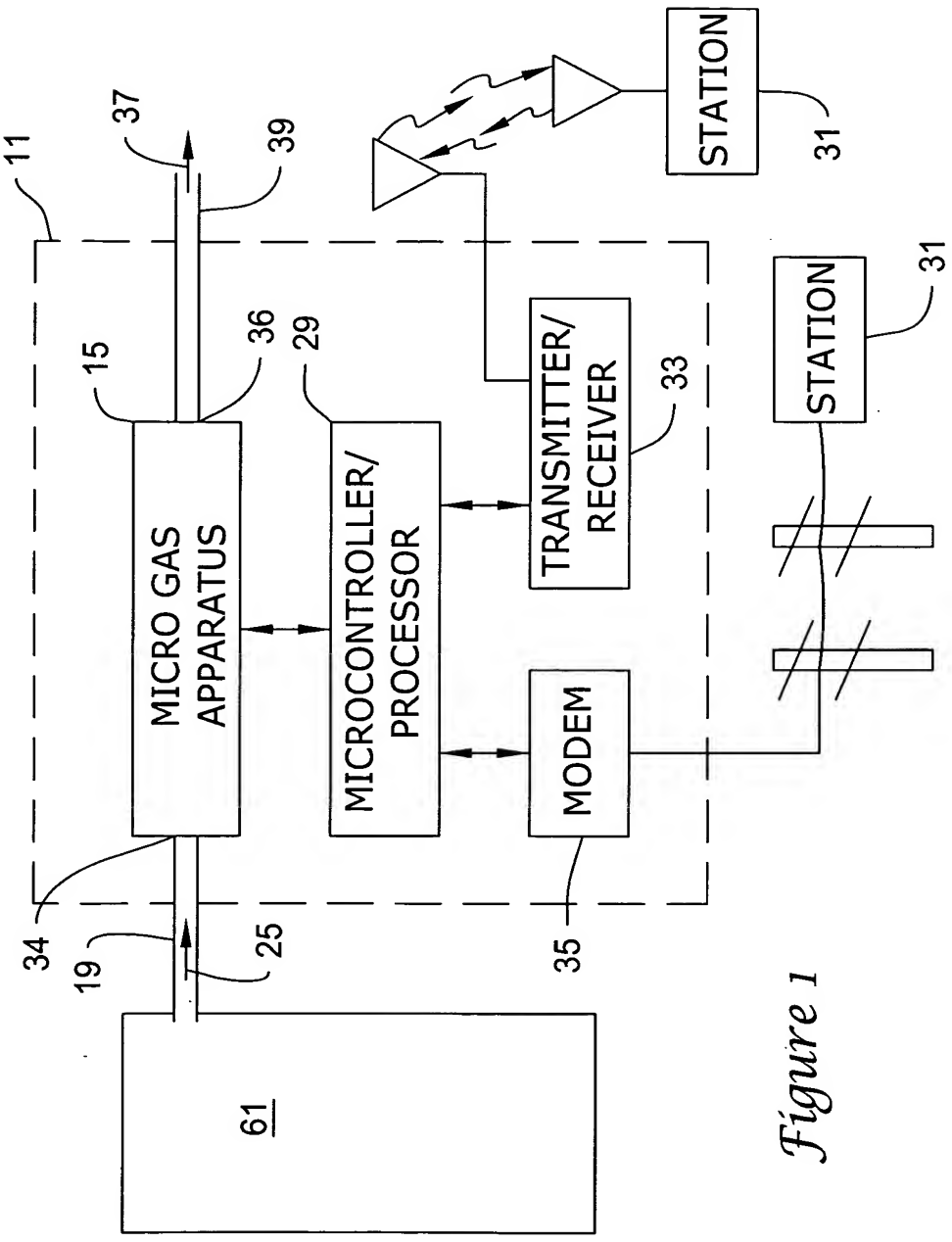

Figure 1

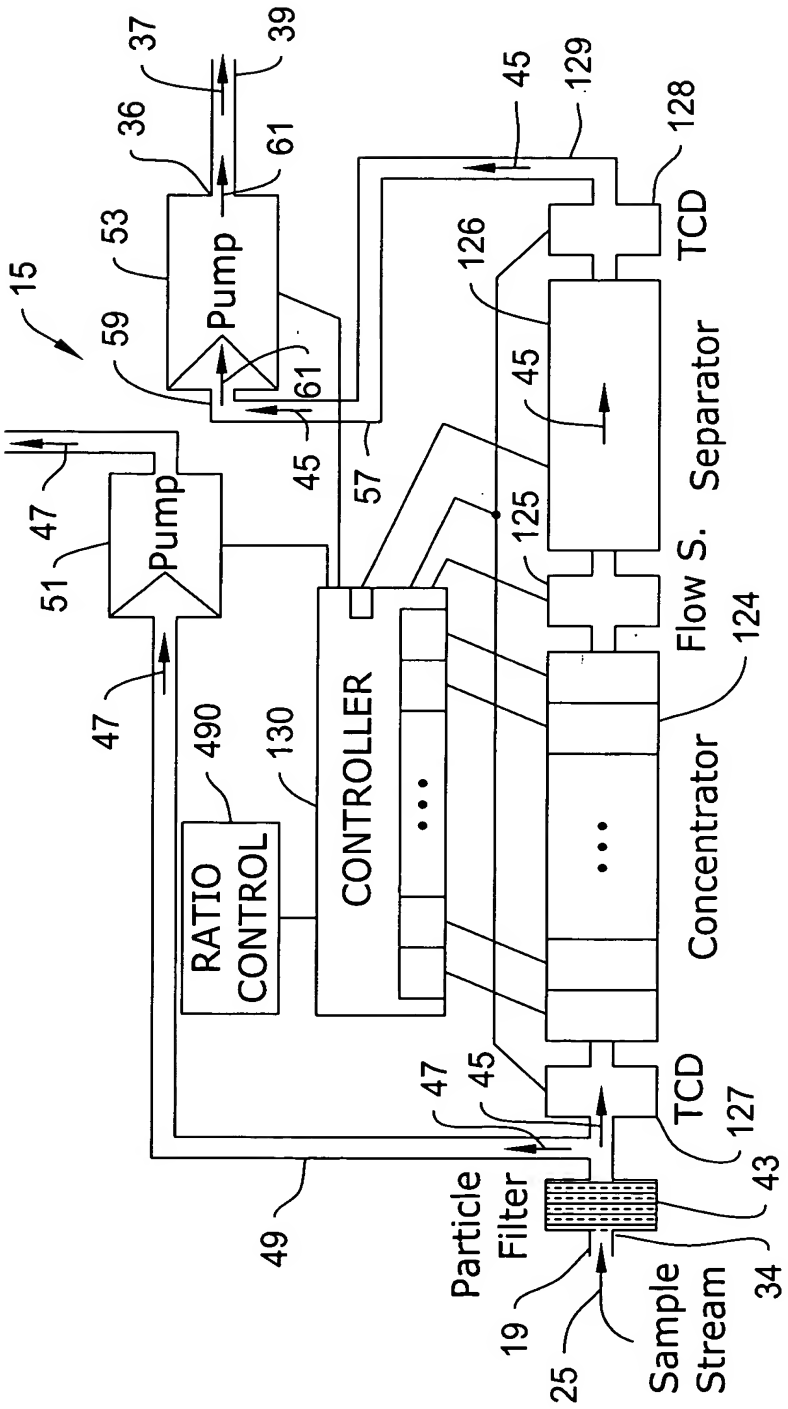
15
Pump
Pump
RATIO CONTROL
CONTROLLER
Flow S. Separator
Concentrator
TCD
TCD
Particle Filter
Sample Stream
37
39
36
61
53
59
61
45
57
47
51
47
490
130
49
45
129
128
126
45
125
124
47
45
127
43
34
19
25

Figure 2

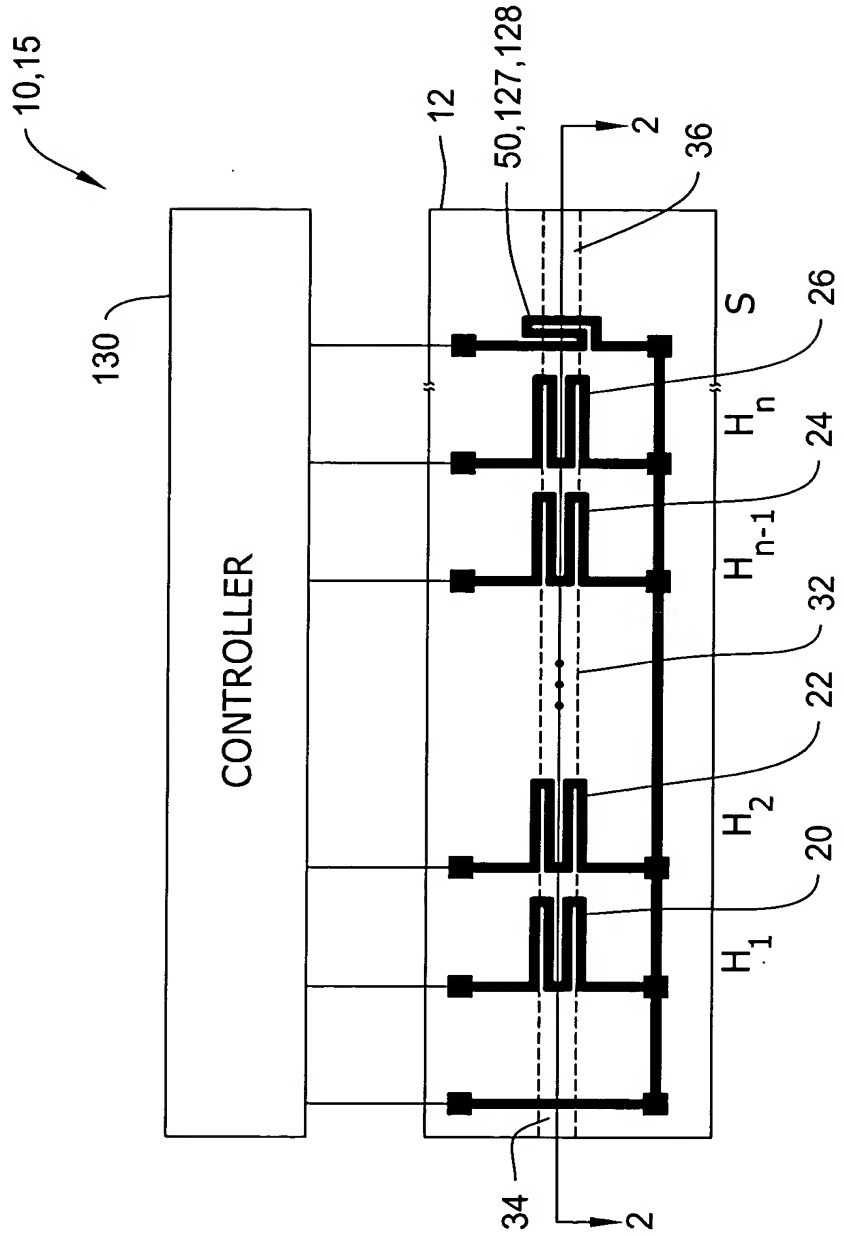
10,15
12
50,127,128
2
36
130
CONTROLLER
S
26
H_n
24
H_{n-1}
32
22
H_2
20
H_1
34
2

Figure 3

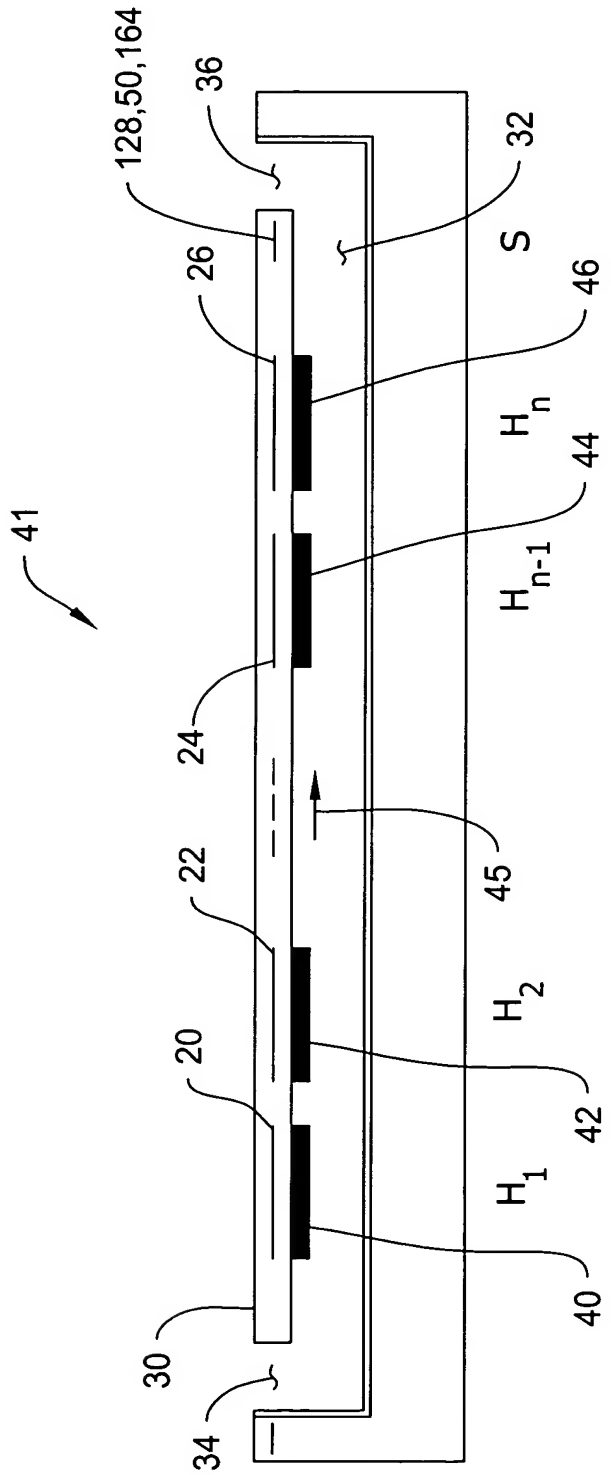

Figure 4

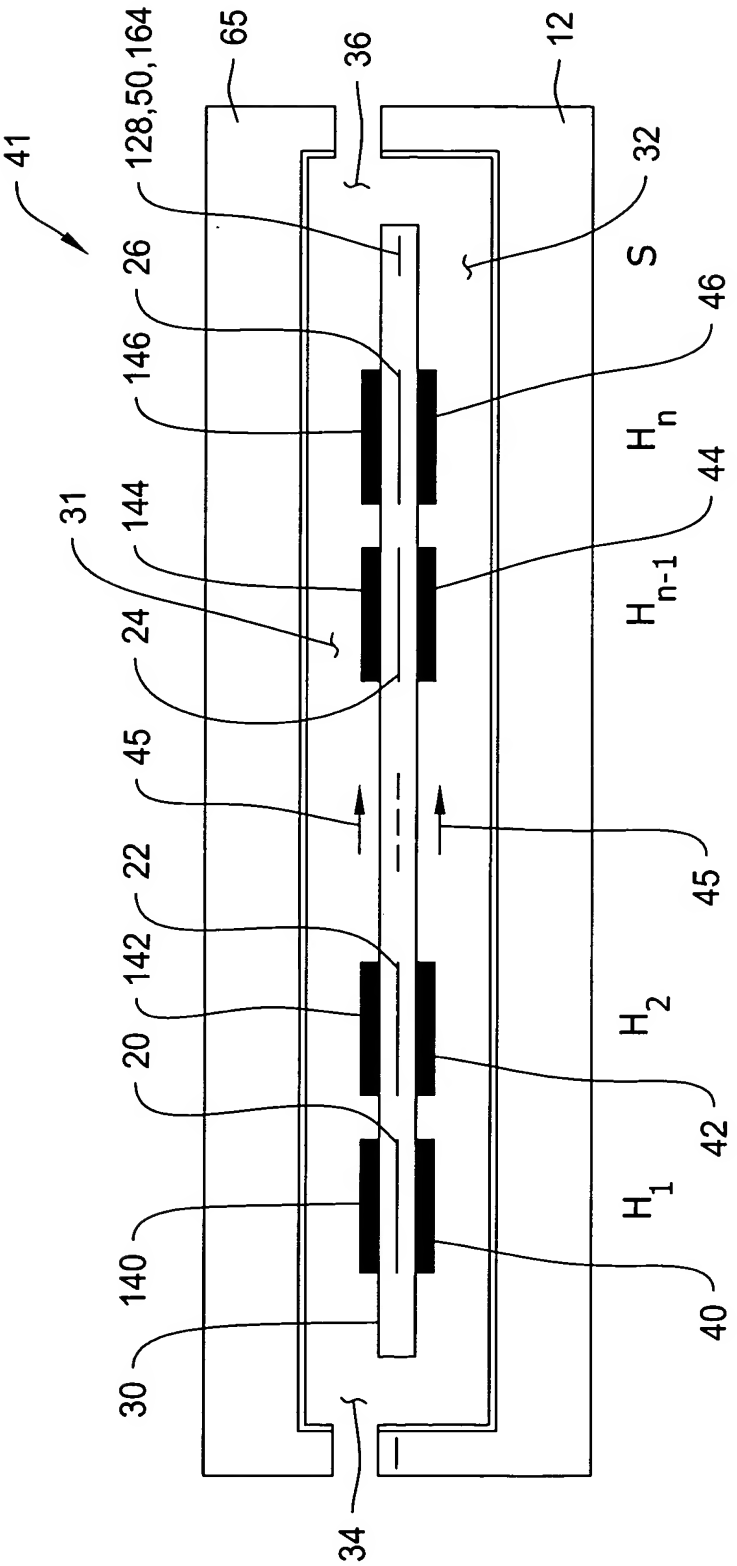
41
128,50,164
65
36
12
32
S
26
146
46
H_n
144
44
H_{n-1}
31
24
45
45
22
142
H_2
20
42
H_1
140
40
30
34

Figure 5

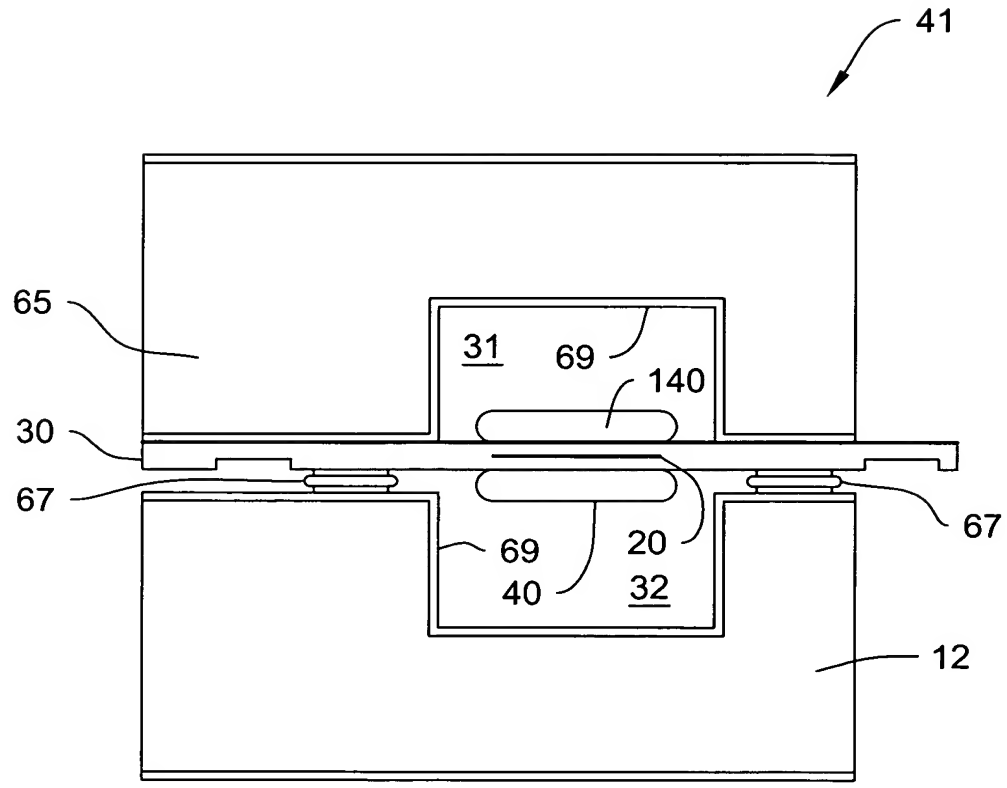

Figure 6A

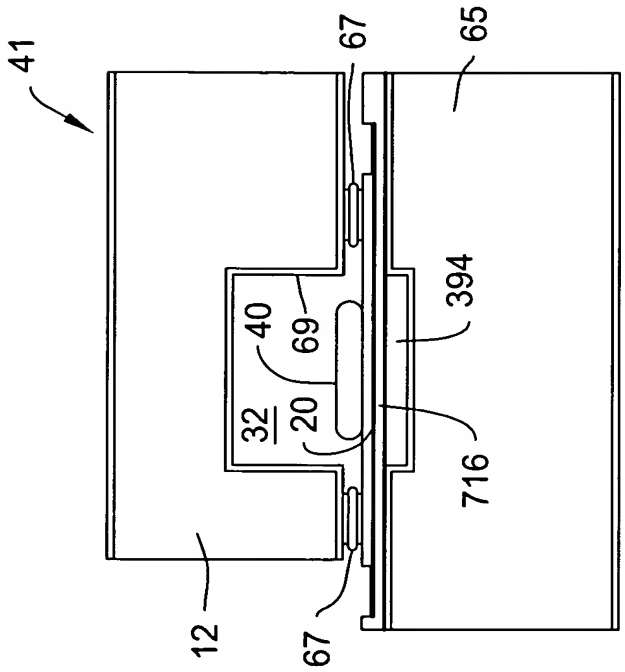

Figure 6C

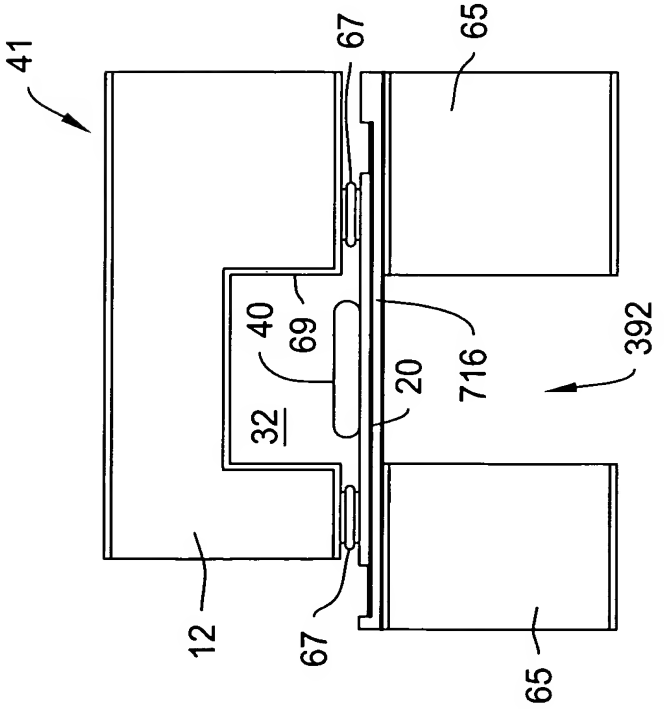

Figure 6B

8/26

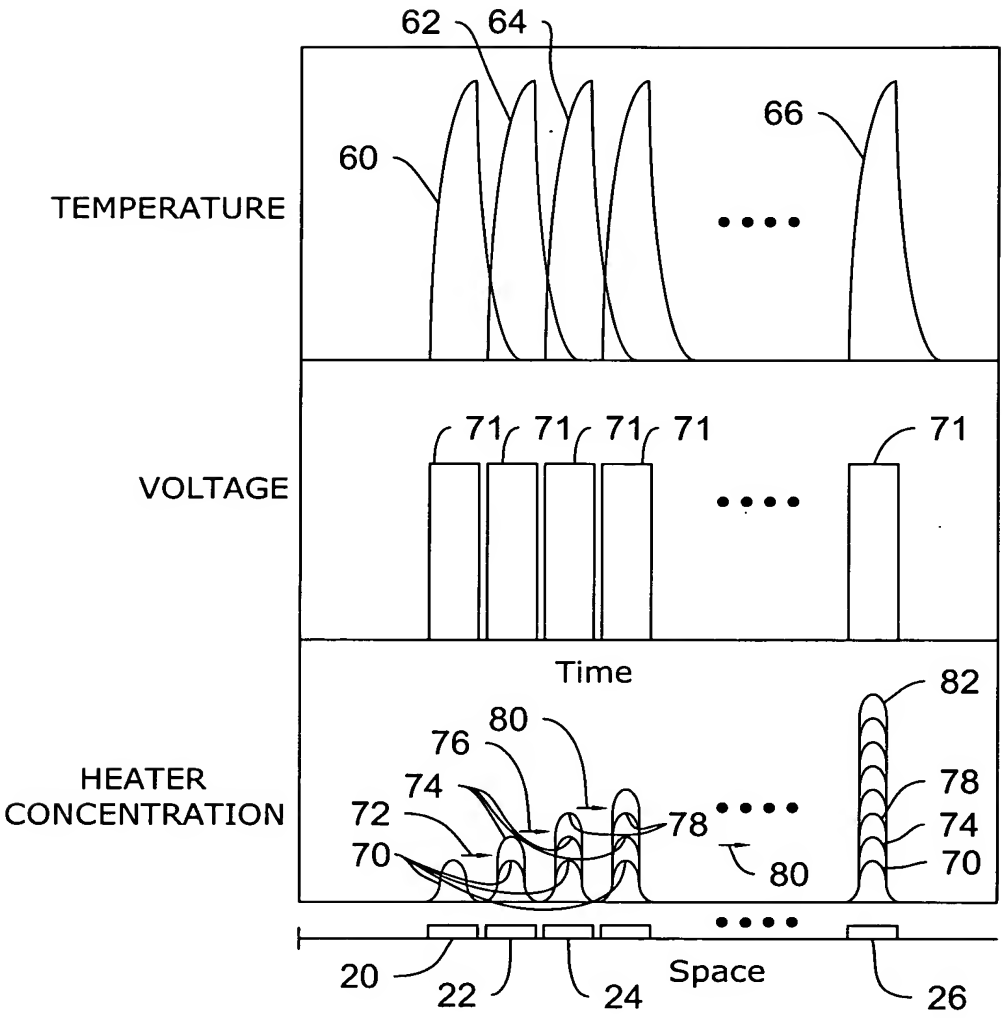
62
64
66
60
TEMPERATURE
71
71
71
71
71
VOLTAGE
Time
82
80
76
74
72
70
78
78
74
70
80
HEATER
CONCENTRATION
20
22
24
Space
26

Figure 7

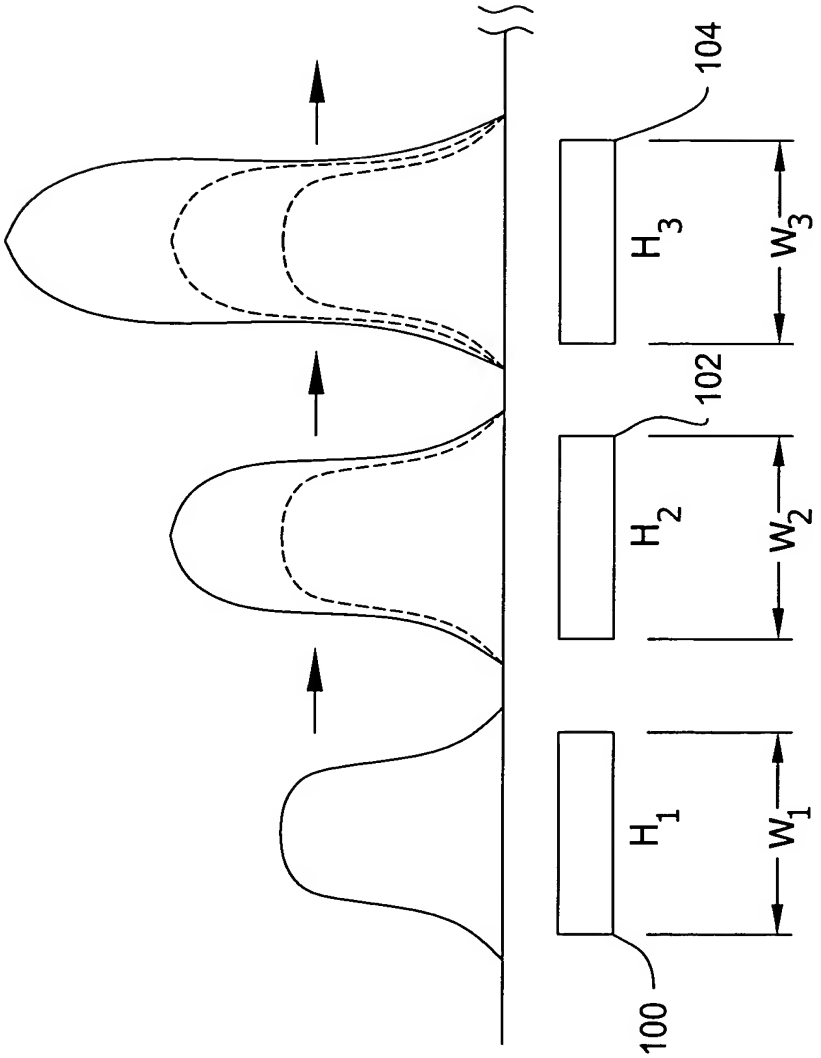

Figure 8

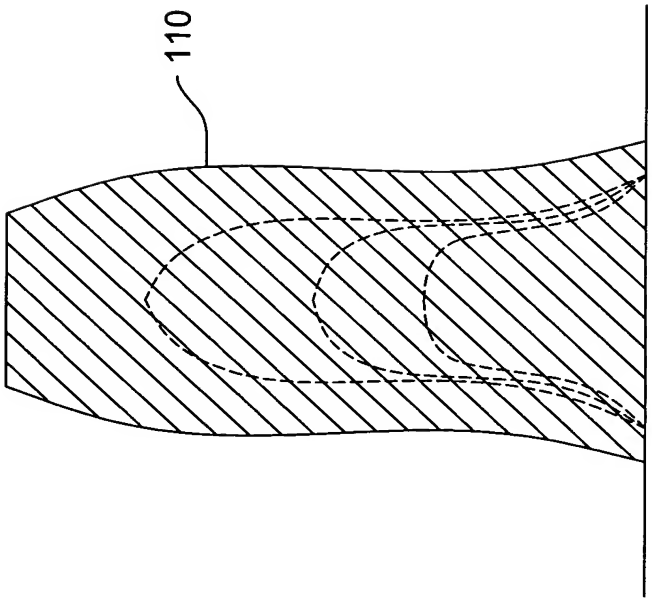

Figure 9

Comparison of Detection Limits in pg/s (MDL) and Selectivities × 10^3 (SEL)

		this work		ref 9 (without background correction)		ref 9 (with background correction)		ref 7[a] (echelle)		ref 8[b] (with background correction)	
element	wavelength, nm	MDL	SEL	MDL	SEL	MDL	SEL	MDL	SEL	MDL	SEL
N	374.2	7.0	6								
S	180.7	1.7	150								
Hg	184.9	0.1	3000								
C	193.1	0.5								53	
P	177.5	1.5	25								
C	247.9	2.6		2.7							
S	251.6	7.0	90	9.3	1.6			58	3.9		
P	253.6			3.3	11			4.2	26		
Hg	253.7	0.1	5000	0.6	77			2.0	91		
Br	470.4			33	0.27	67	4.0	20	1.4	38	0.53
Br	478.6	75	39	34	0.60						
Cl	479.5	39	25	43	0.61	86	1.5			32	1.0
Cl	481.0							32	2.4		
H	486.1	2.2		16							
S	545.4	7.2	26	33	0.08	52	4.6	126	0.25	234	0.07
D	656.1	2.5	0.6[c]	7.4	0.19						
H	656.3	3.0		7.5						37	
F	685.6	40	30	20	0.57	180	11.4	17	3.5	11	0.82
O	777.2	75	25								

[a] Reference 7 uses peak width at base instead of peak width at half height to determine MDL, and the numbers have been adjusted accordingly for comparison. [b] Reference 8 uses 1σ instead of peak to peak (6σ) to measure noise for MDL, and their numbers have been adjusted accordingly for comparison. [c] Versus hydrogen.

Figure 10

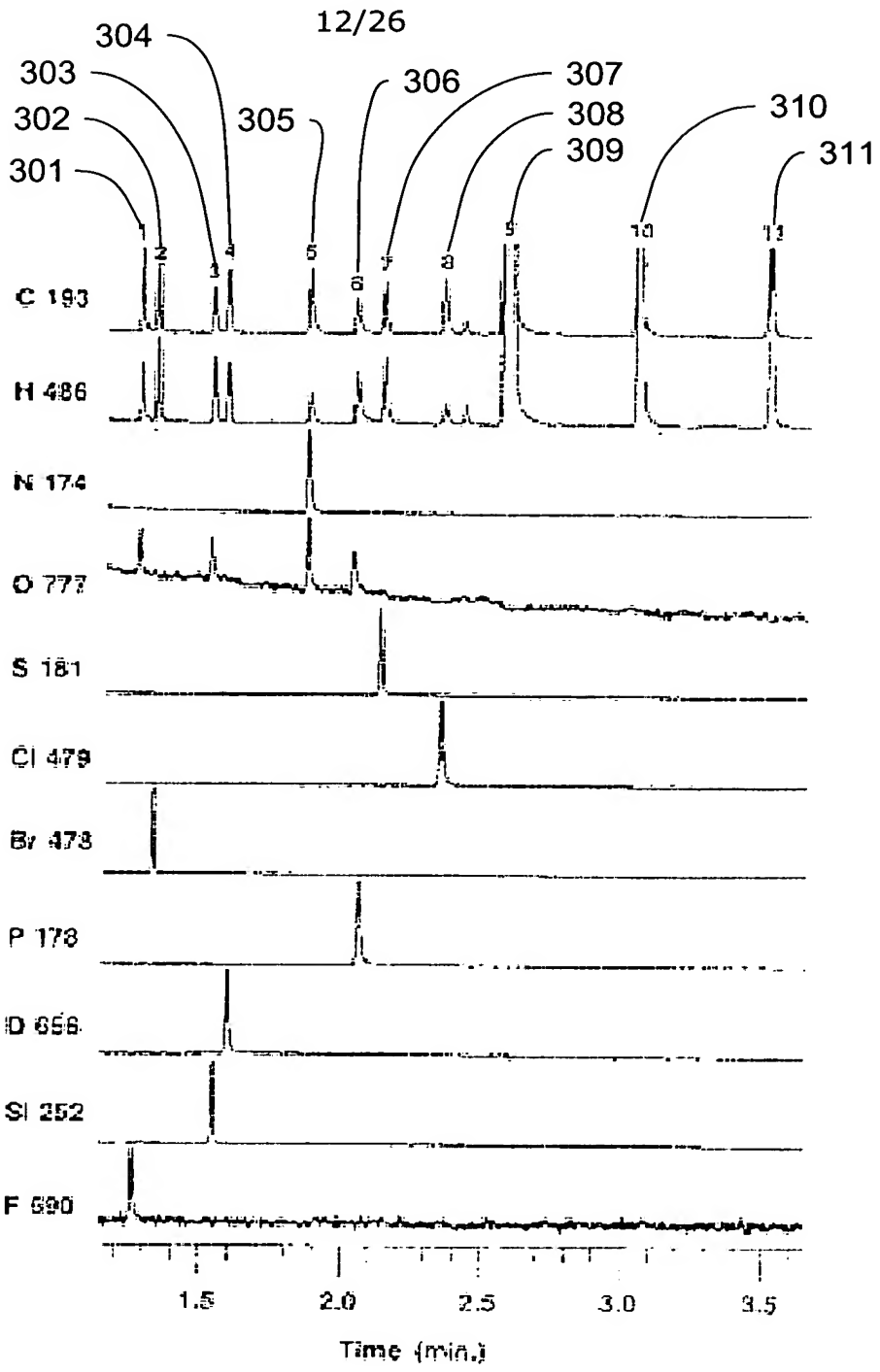
12/26
304
303
302
301
305
306
307
308
309
310
311
C 193
H 486
N 174
O 777
S 181
Cl 479
Br 473
P 178
D 656
Si 252
F 690
1.5
2.0
2.5
3.0
3.5
Time (min.)

Figure 11

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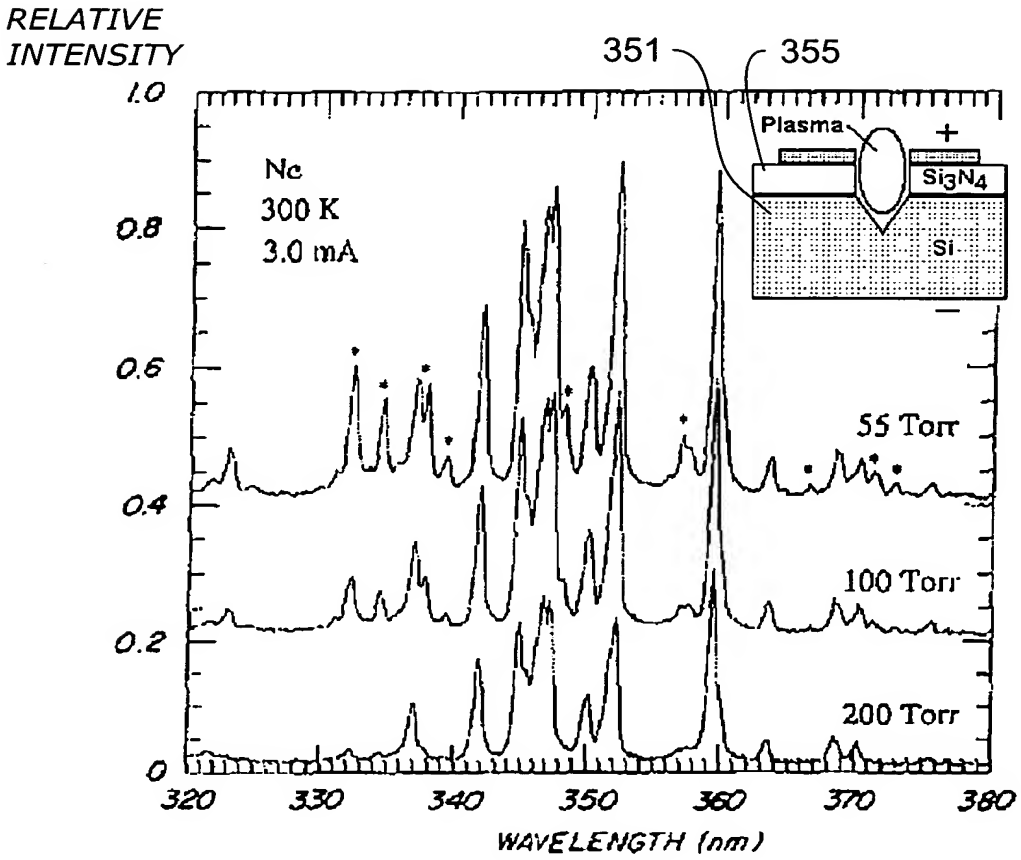

Figure 12

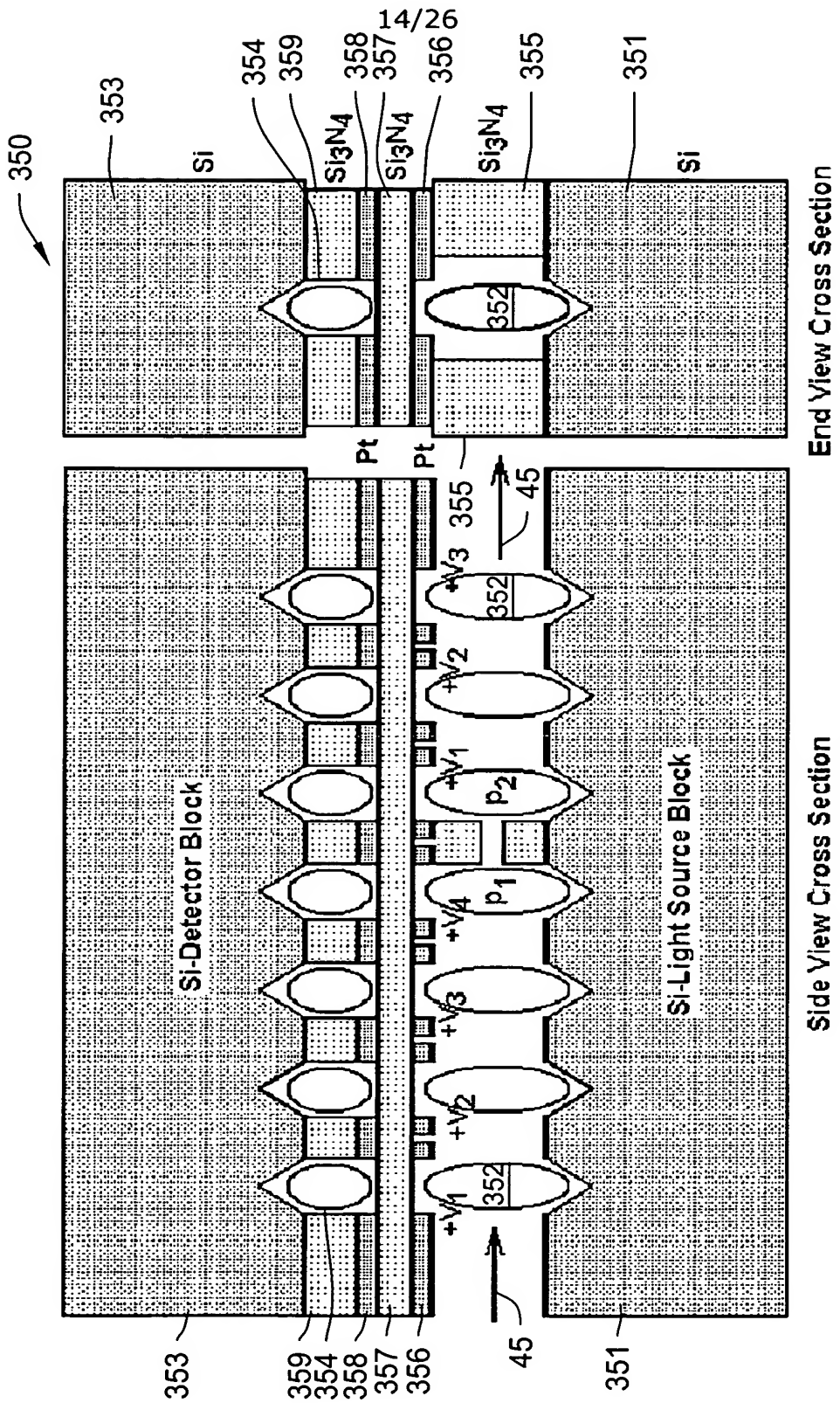
14/26
350
353
354
359
358
357
356
355
351
Si
Si_3N_4
Si_3N_4
Si_3N_4
Si
Pt
Pt
End View Cross Section
45
355
352
+V3
+V2
+V1
+V4
+V3
+V2
+V1
P_2
P_1
Si-Detector Block
Si-Light Source Block
Side View Cross Section
353
359
354
358
357
356
45
351

Figure 13

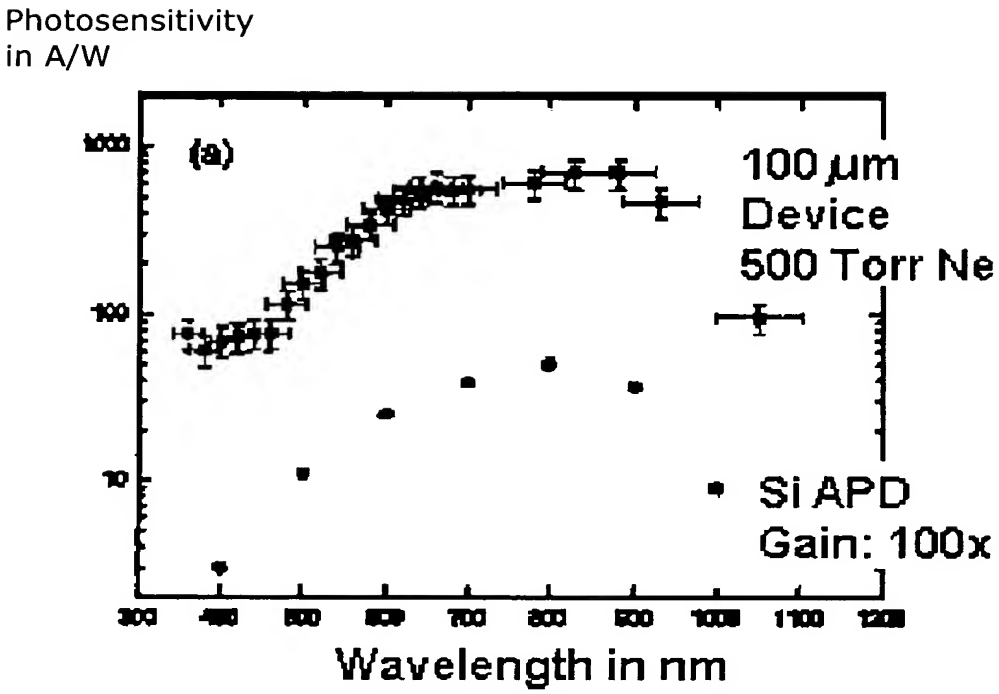
Photosensitivity
in A/W
(a)
100 µm
Device
500 Torr Ne
Si APD
Gain: 100x
Wavelength in nm

Figure 14

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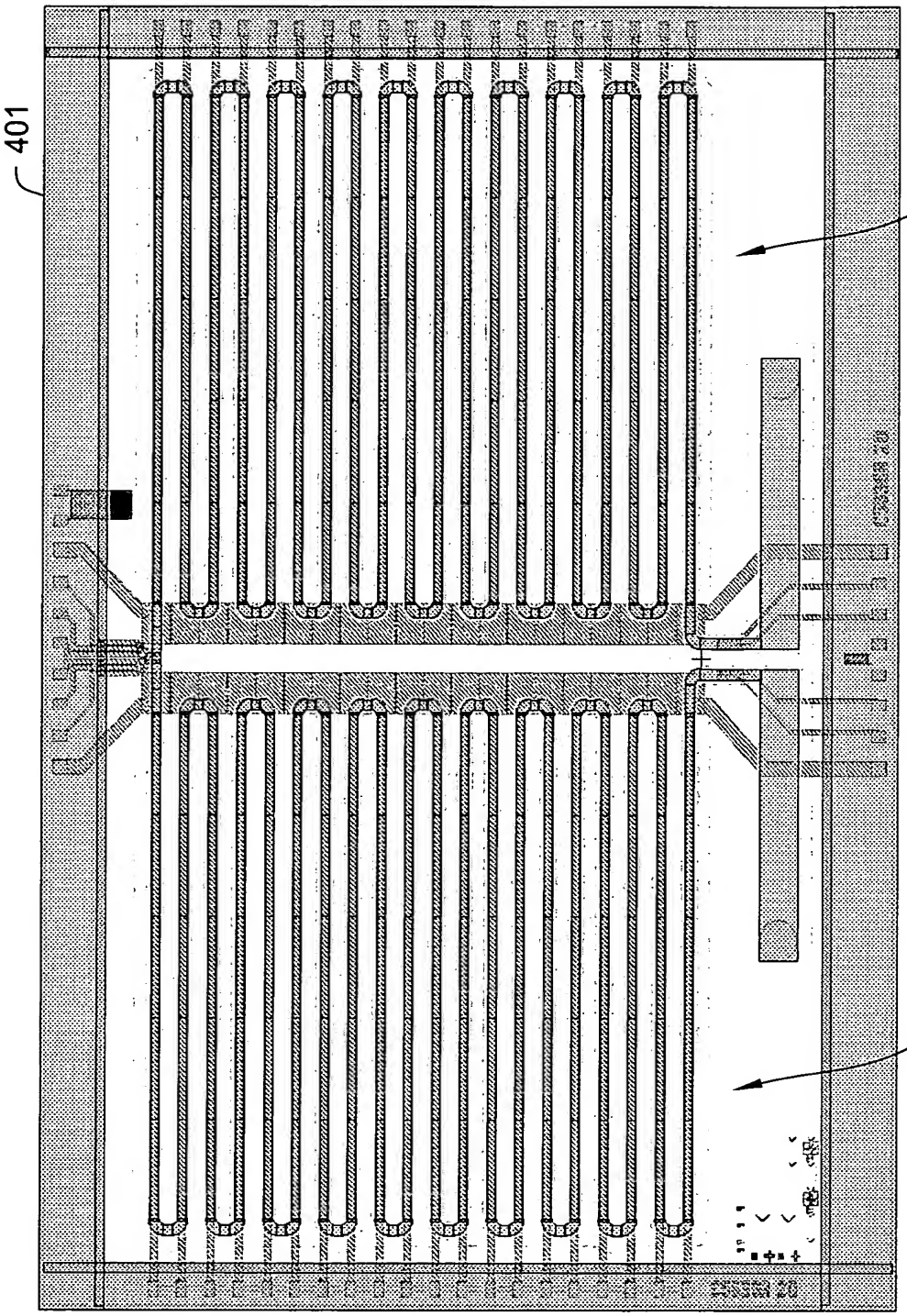

Figure 15

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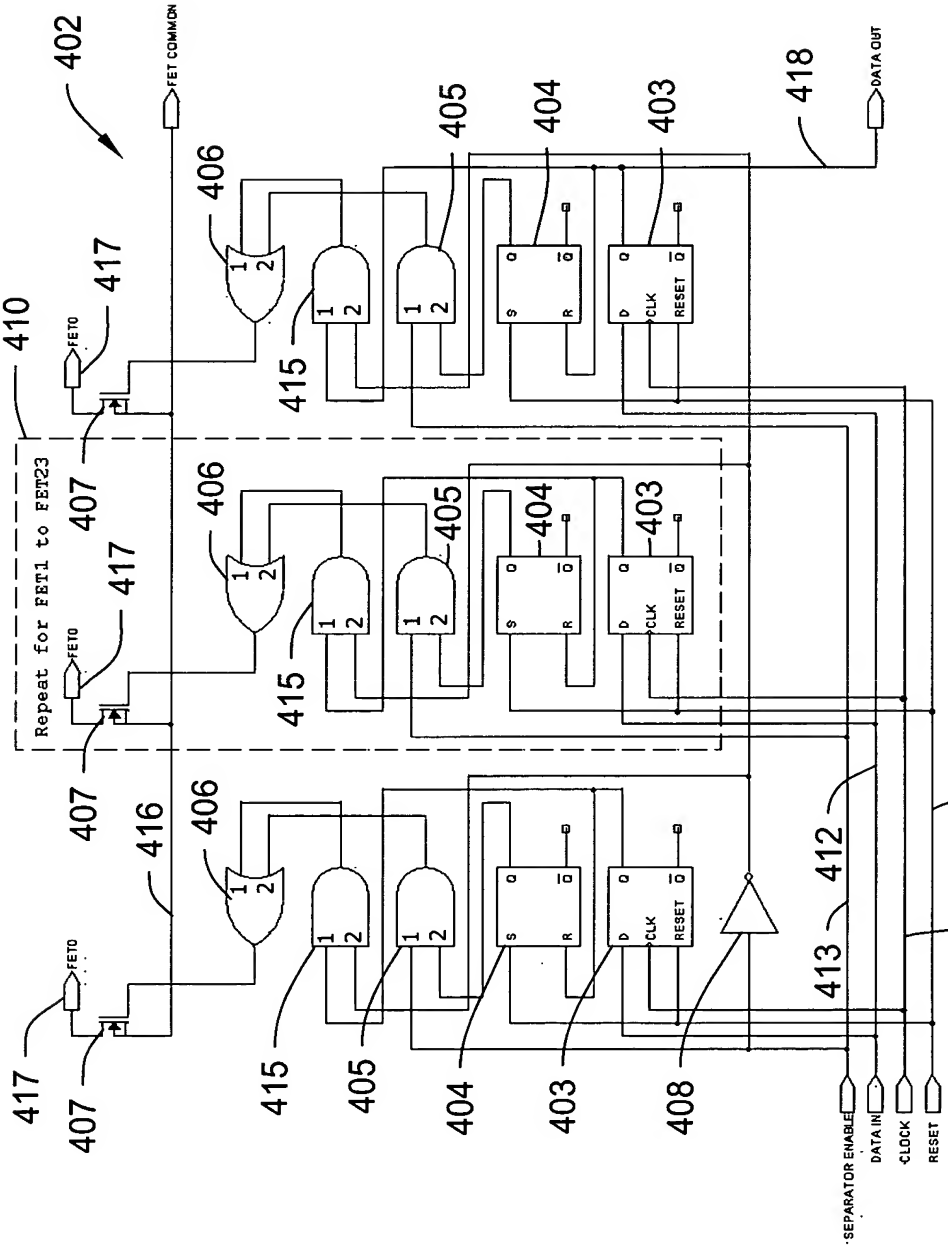

Figure 16

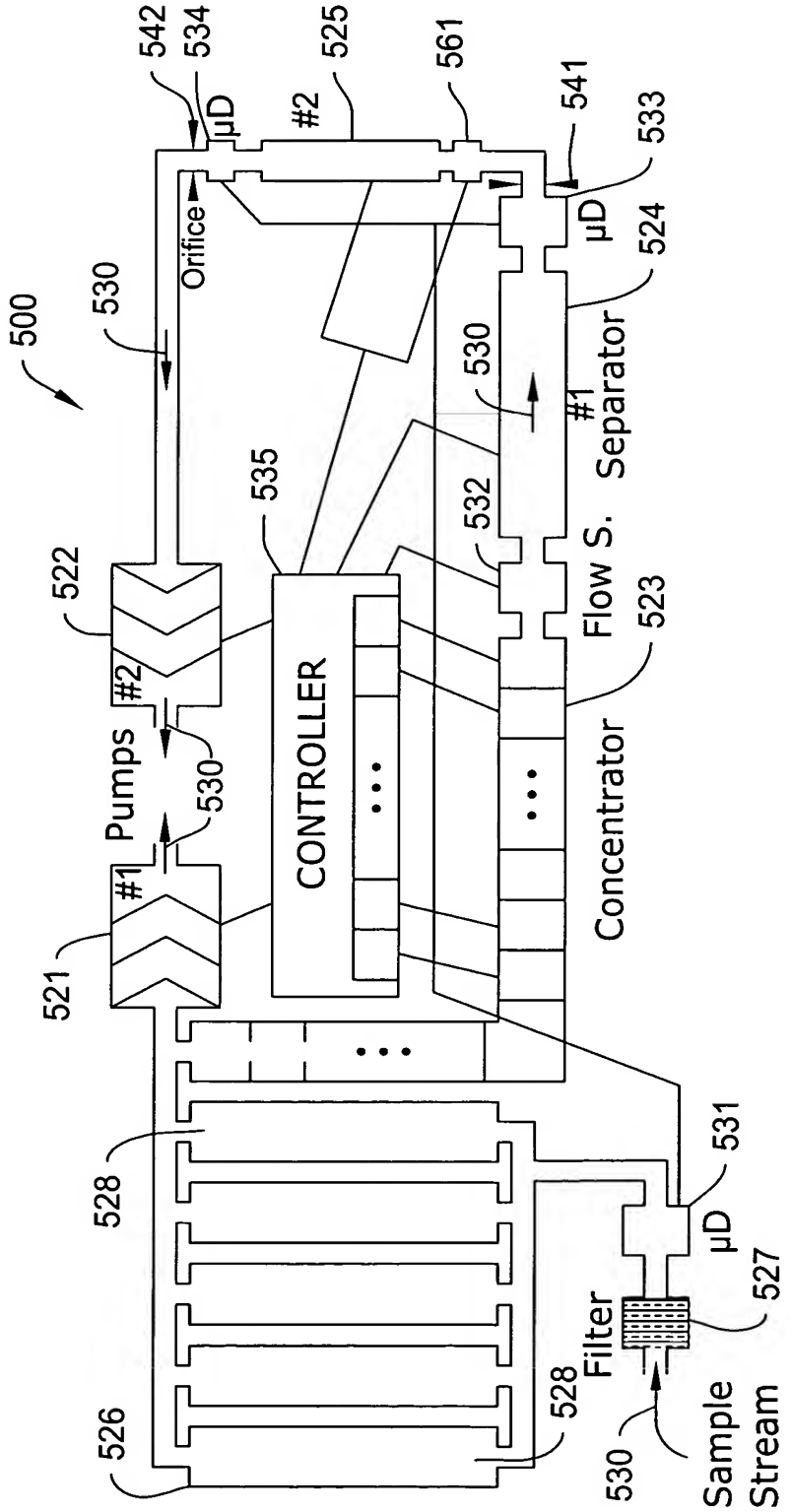
500
542
534
μD
525
#2
561
541
533
μD
524
Separator
#1
Flow S.
523
Concentrator
530
Orifice
530
535
532
522
#2
Pumps
#1
530
CONTROLLER
521
528
526
528
531
μD
527
Filter
530
Sample
Stream

Figure 17

19/26

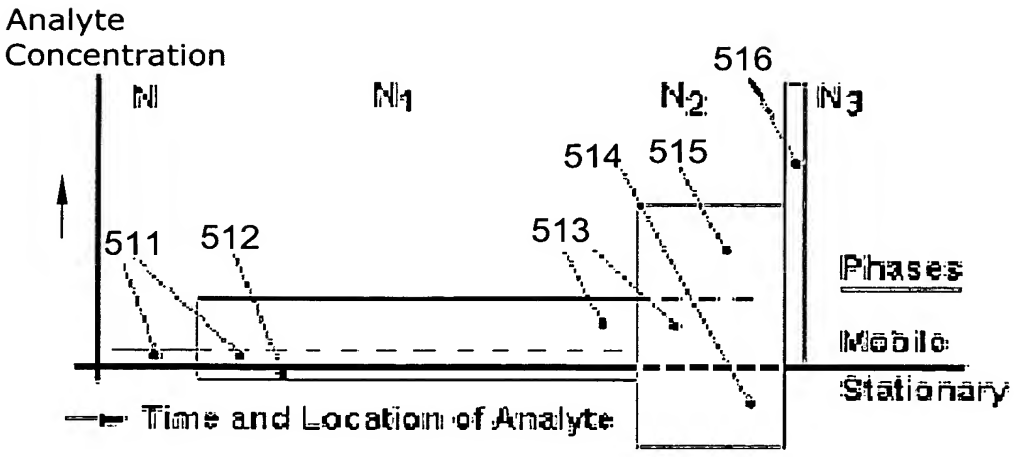

Figure 18

Analyte Masses = Film Length x Concentration

	N ppt	N_1 ppt	N_2 ppt	N_3 ppt
A	∞x1	500x100	5x10,000	1x 50,000
B	∞x1	1000x100	10x10,000	1x100,000
C	∞x1	5,000x100	50x10,000	1x500,000
D	∞x1	10,000x100	100x10,000	1x520,000+less
E	∞x1	100,000x100	1,000x10,000	10x1,000,000 (10^7)

Figure 19

Pres.Drop at 100 cm/s, 100x100 μm

No. of Elem. N1 -	Length L cm	Pres. Drop Δβ psi	Peak P. Q watts
50	0.5	2.629	20.5
505	0.1	5.311	41.3
1010	0.1	10.621	82.6

Figure 20

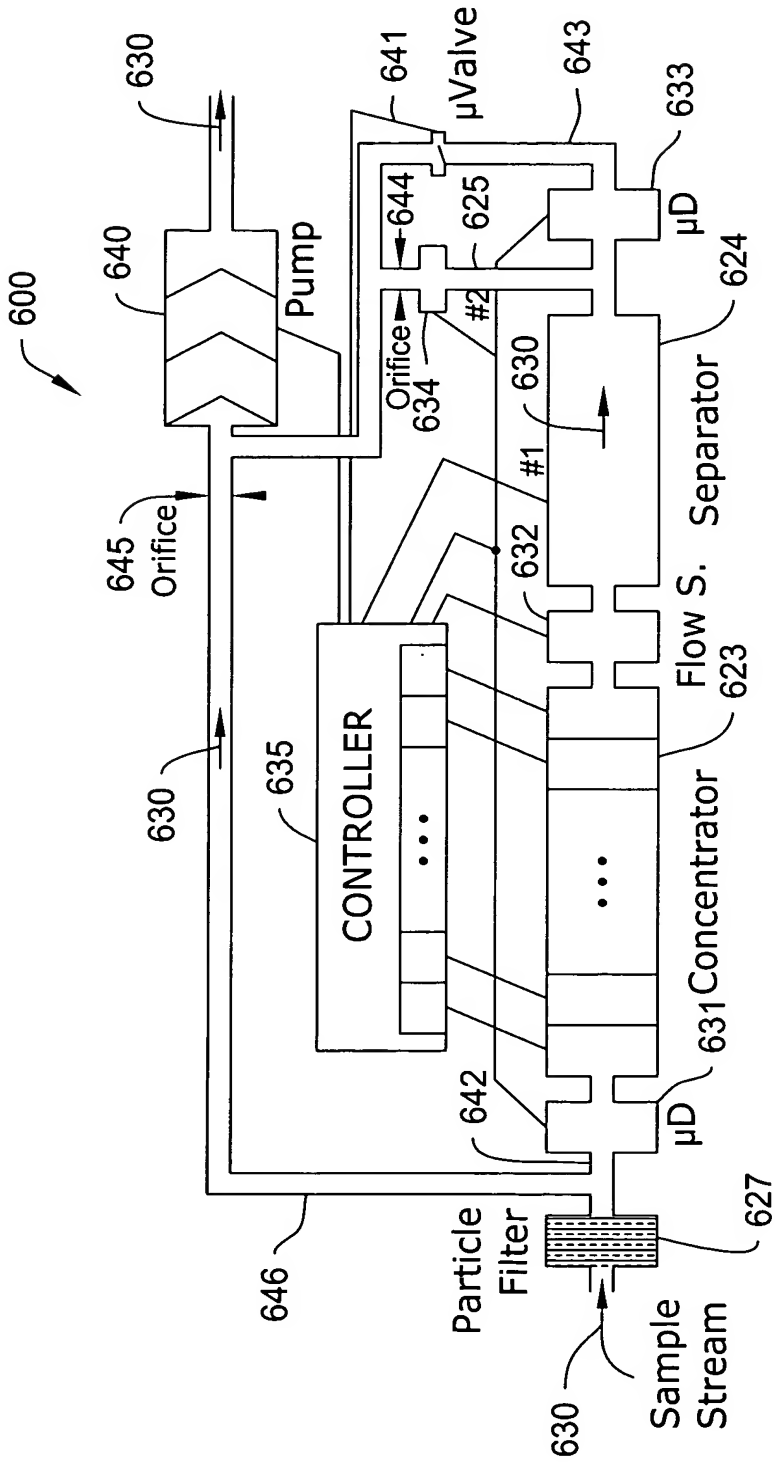
600
630
641
µValve
643
633
640
Pump
644
625
µD
624
#2
Orifice
634
630
#1
Separator
645
Orifice
632
Flow S.
623
630
635
CONTROLLER
Concentrator
631
642
µD
627
646
Particle
Filter
Sample
Stream
630

Figure 21

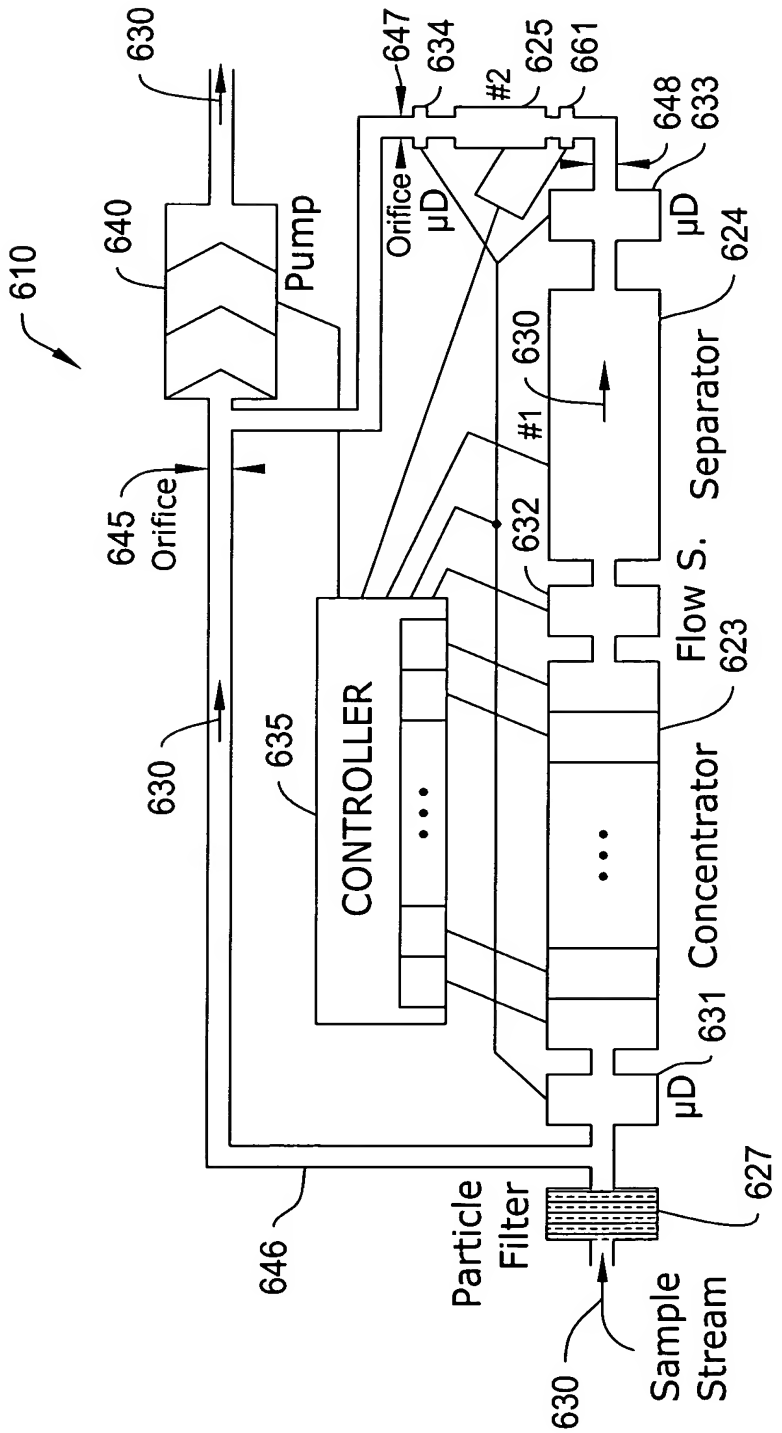
610
630
640
Pump
647
634
#2
625
661
648
633
Orifice
µD
µD
624
630
#1
Separator
645
Orifice
632
Flow S.
623
630
635
CONTROLLER
Concentrator
631
µD
627
646
Particle
Filter
630
Sample
Stream

Figure 22

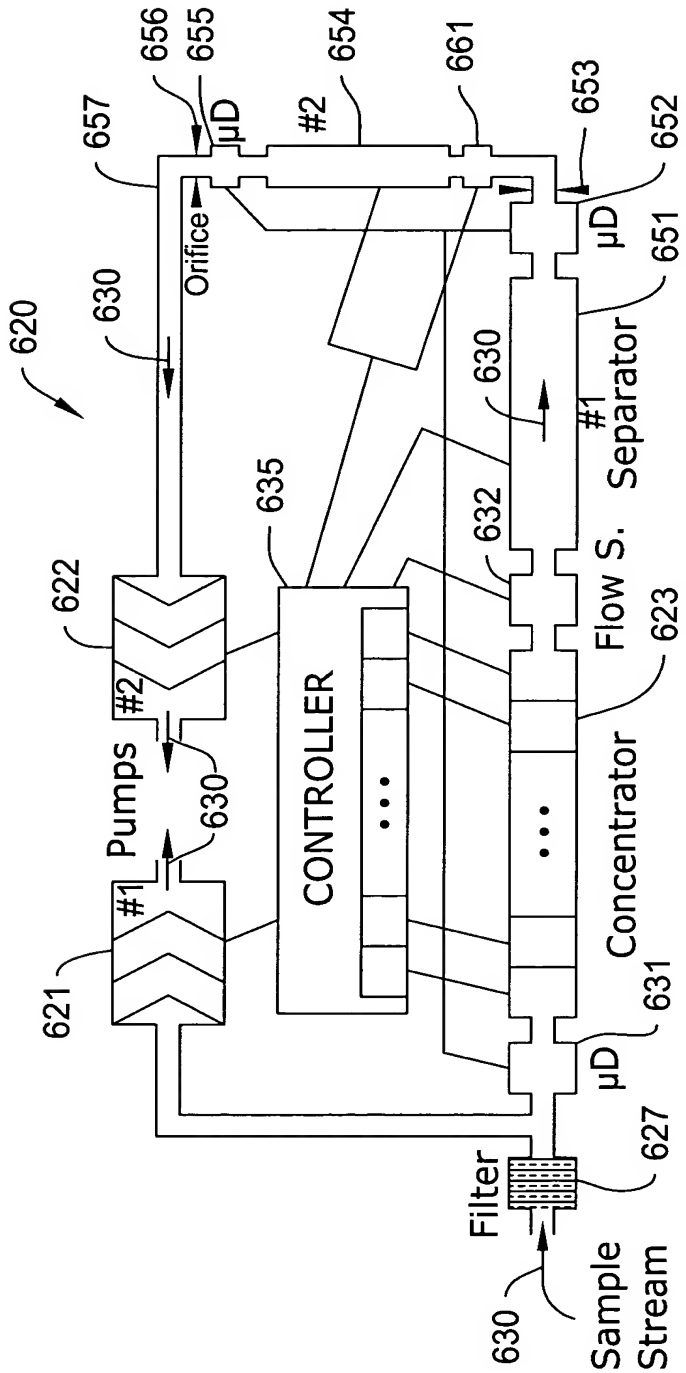
620
630
Orifice
657
656
655
µD
#2
654
661
653
652
µD
651
630
#1
Separator
Flow S.
623
Concentrator
631
µD
627
Filter
630
Sample
Stream
635
632
630
622
#2
Pumps
630
#1
621
CONTROLLER

Figure 23

Table: Design of µGc-µGC System on the Basis of a PHASED Structure

	v in cm/s	ID in cm	L in cm	s in µm	ℓ in mm	V in cm3/min	$\triangle$p in psi
µGC-1	50	0.014	25	1	5	0.588	.671
µGC-2	250	0.007	10	0.15	2.5	0.588	5.365

	v	to	Half-Width $\triangle$t	k=6 tR	k=0.2 v(optimal)	k=2 v(optimal)	k=2 R	k=0.2 $\triangle$R(v-vo)
	cm/s	ms	ms	sec	cm/s	cm/s	-	%
µGC-1	50	500	20	3.00	68.8	56	8.76	2.5
µGC-2	250	40	2	0.24	149.2	118	8.00	6.2

Figure 24

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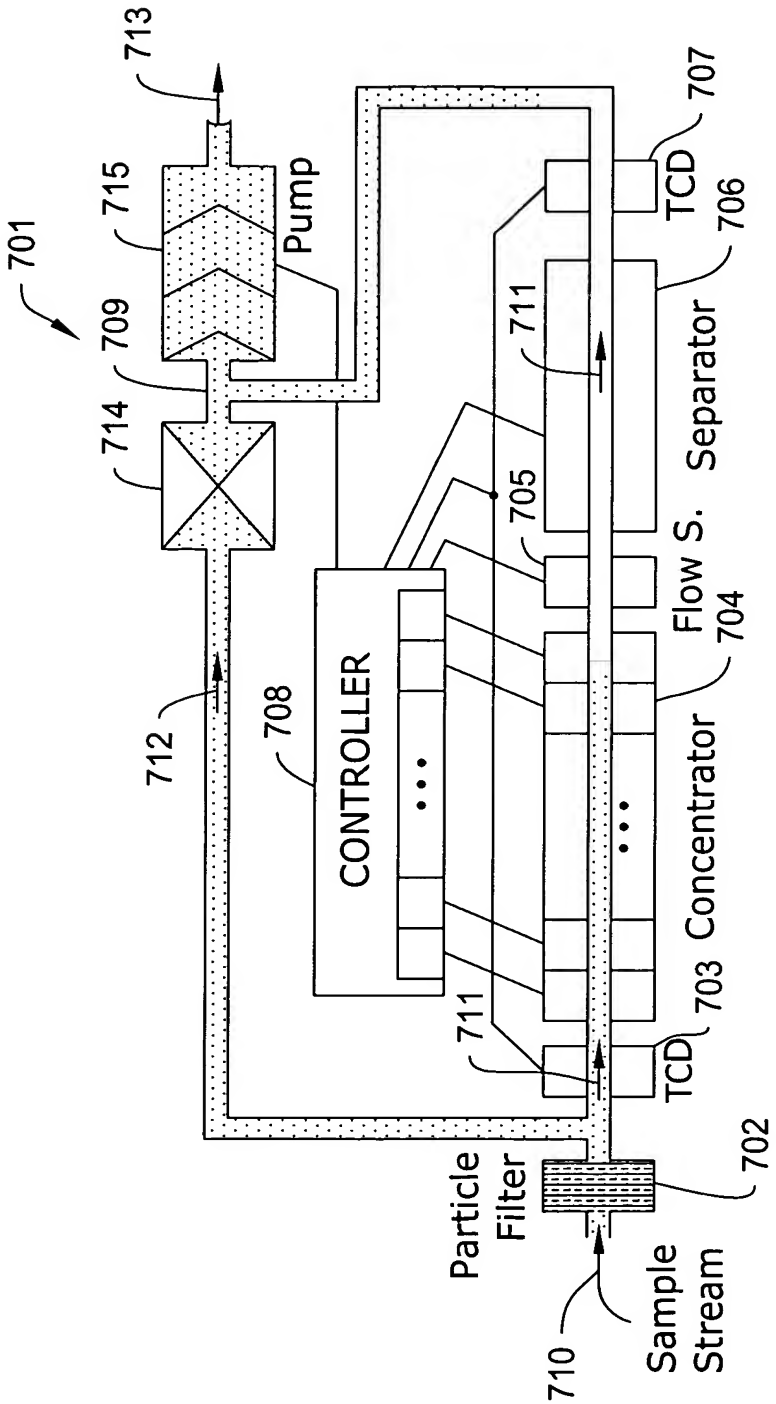

Figure 25

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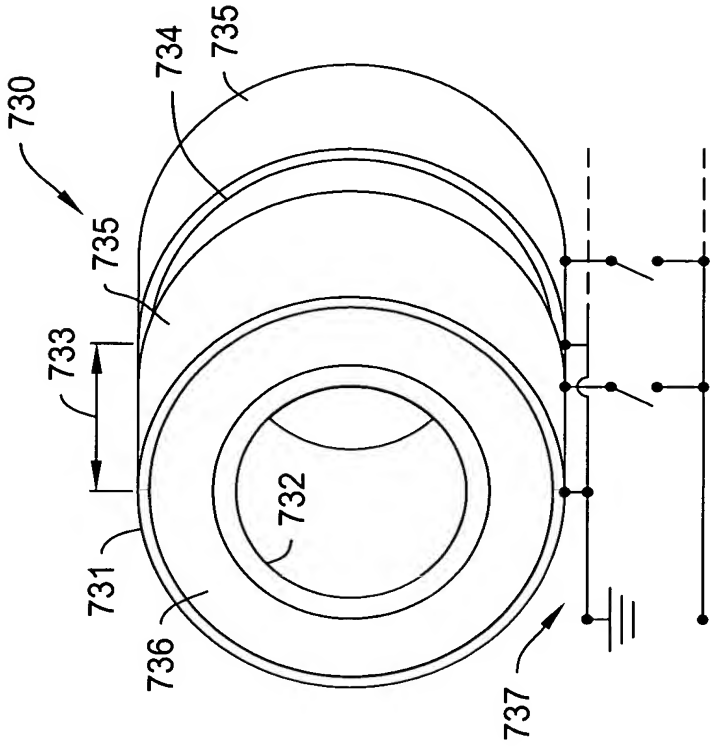

Figure 26B

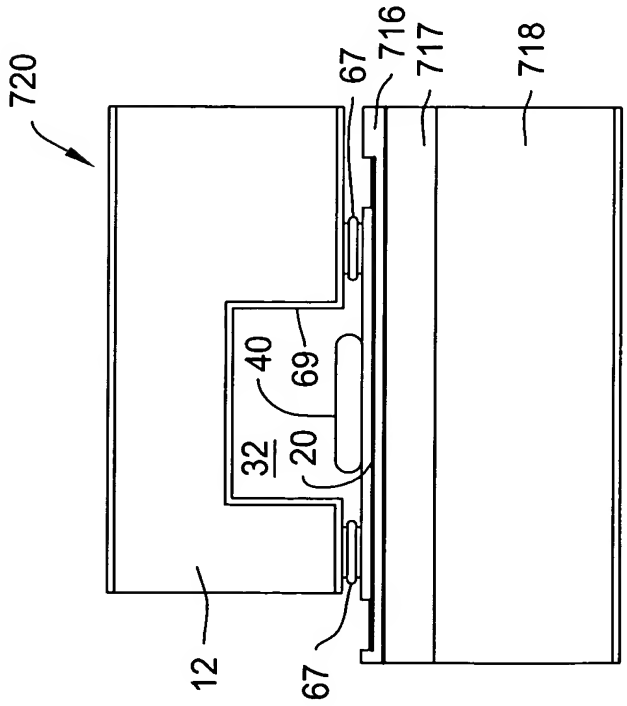

Figure 26A